

IMMEDIATE EFFECTS OF MANIPULATION OF THE TALOCRURAL JOINT ON STABILOMETRY AND BAROPODOMETRY IN PATIENTS WITH ANKLE SPRAIN

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ABSTRACT

Objective: This study assessed the immediate effects of talocrural joint manipulation on stabilometric and baropodometric outcomes in patients with grade II ankle sprain.

Methods: Fifty-two field hockey players (35 men and 17 women) between 18 and 40 years old (mean = 22.5 years, SD = 3.6 years) were included in this study. A simple blind, inpatient, placebo-controlled, and repeated-measures study was carried out. All the patients underwent a baropodometric study performed with a Foot Work force platform (4 times; pre-post placebo group and pre-post intervention group). The sample was subjected to two techniques of manipulative treatment: (a) talocrural joint manipulation and (b) posterior gliding manipulation over the talus. In a second instance, placebo manipulation was applied. Unilateral analysis of variance and multivariate analysis of variance were used for statistical analysis.

Results: The results in the intervention group revealed significant differences in the percentage of posterior load on the foot ($P = .015$) and the percentage of bilateral anterior load ($P = .02$) before and after the manipulation. The placebo group did not show any change in any of the variables except for area ($P = .045$). Intergroup comparison revealed statistically significant differences in the increase in percentage of posterior load on the manipulated foot, percentage of bilateral posterior load, percentage of anterior load on the manipulated foot, and percentage of bilateral anterior load (with the exception of the total load on the foot).

Conclusions: The application of caudal talocrural joint manipulation, as compared with placebo manipulation, in athletic patients with grade II ankle sprain redistributed the load supports at the level of the foot. (*J Manipulative Physiol Ther* 2007;30:186-192)

Key Indexing Terms: *Ankle Injuries; Musculoskeletal Manipulations; Proprioception*

Postural control is achieved by sensory information, postural reactions (feedback or feedforward), personal experiences (memory), muscular activity, or joint movements. Sensory information plays an important

role in postural control. The oculomotor, vestibular, and somatosensory systems provide the necessary information for posture to adapt to any situation.¹ The foot can be considered as a proprioceptive factor of the postural system because it allows for adjustment of the information and segmental adjustment of the leg with respect to itself, considered as a fixed point.² Despite this, there is a need to improve our understanding of the normal behavior of the ankle joint to improve the treatment of lower extremities.³

When a patient is placed in a standing position, the center of gravity maintains a vertical projection inside a cylinder of at least 1 cm² of the cross-sectional area. Each time the center of gravity is moved, the mechanisms responsible for the maintenance of posture are activated to return it to its original position by means of small discharges of muscle activity.⁴ In fact, it is currently known that the relationship between perception and action in posture is not simple and that multiple aspects—and their relationships—should be processed.⁵ As such, we should study posture without biases from respiration,⁶ muscle fatigue,⁷ or dental occlusion.⁸

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Fig 1. Manual assessment of the posterior glide of the talus.



Fig 3. Posterior gliding manipulation of the talus.



Fig 2. Talocrural joint manipulation.

Stabilometry performed with a force platform is an innocuous, objective, and reproducible method that can be used in individuals of either sex and regardless of weight or height.⁹ The aim of stabilometry is to obtain different values related to stability and postural systems, such as parameters characterizing the behavior of standing.¹⁰ In addition, use of force platforms is the method most commonly applied to evaluate the interaction between the foot and the support surface in baropodometry¹¹ because measurement of the pressure of the sole of the foot on the ground provides an indication of the function of the ankle and foot in the orthostatic posture or during other functional activities.¹² Furthermore, the platform provides information about possible risk factors¹¹ or several pathologies, such as diabetes,¹³⁻¹⁵ rheumatoid arthritis,¹⁶ neurologic diseases, control of orthosis,^{17,18} gait patterns, and foot pressure.¹⁹⁻²¹

Table 1. Demographic and clinical characteristics of the sample (N = 52)

Characteristic	Distribution
Sex (male/female ratio)	35:17
Age (y, mean±SD)	22.5±3.6
Height (cm, mean±SD)	173.8±7.6
Weight (kg, mean±SD)	69±10
Years practicing sports (mean±SD)	5.7±5.7

It has been shown that manipulative spinal therapy produces increased range of motion.²²⁻²⁴ In addition, other studies that analyzed the effects of vertebral manipulations found decreased pain and increased activity of the sympathetic nervous system.²⁵⁻²⁹ However, there are few studies in the peer-reviewed literature that had analyzed treatment effects on peripheral joints.^{27,30,31} Some authors investigated treatment effects on the range of motion in these joints, but their results varied.³²⁻³⁴ Finally, few studies had assessed the effects of joint manipulation on posture.

Ankle sprains are one of the most frequent problems in clinical practice.^{35,36} Loss of mobility of the talus can play a relevant role in the adaptation of the foot to the surface during walking³⁷ because the subtalar joint is responsible for performing the adaptive movements of the foot on the ankle.³⁸ Therefore, it seems that disorders of mobility of this joint could have some repercussions on the static and dynamic functions of the body.³⁹

Our aim was to assess the immediate effects of caudal talocrural joint manipulation on stabilometric and baropodometric outcomes in patients who had had one or more episodes of grade II ankle sprain.

Table 2. *Stabilometric data before and after the manipulation (intervention group)*

	Premanipulation (N = 52)	Postmanipulation (N = 52)	95% confidence interval for the difference	P
LOAD%ANT	32.64 ± 5.099	32.84 ± 5.248	-1.282 to 0.876	.707
LOAD%POS	17.38 ± 5.319	16.09 ± 5.008	0.398 to 2.197	.015*
LOAD%FOOT	50.02 ± 6.414	48.99 ± 5.950	-0.132 to 2.191	.081
L%ANTBI	64.17 ± 8.132	66.34 ± 7.548	-3.714 to -0.629	.02*
L%POSBI	35.83 ± 8.132	33.66 ± 7.550	0.628 to 3.713	.02*
CGF-CGB distance	11.23 ± 1.978	11.54 ± 2.158	-0.618 to 0.005	.053
P _{mean} (kgf/cm ²)	0.75 ± 0.179	0.73 ± 0.160	-0.010 to 0.036	.251
P _{max} (kgf/cm ²)	4.19 ± 1.282	4.17 ± 1.229	-0.180 to 0.204	.901
AREA (cm ²)	143.84 ± 25.286	143.95 ± 26.918	-2.698 to 2.475	.931

Group values are expressed as mean ± SD. LOAD%ANT, Percentage of load on the forefoot; LOAD%POS, percentage of load on the rear foot; LOAD%FOOT, percentage of load on the foot; L%ANTBI, bilateral anterior load; L%POSBI, bilateral posterior load; P_{mean}, mean pressure; P_{max}, maximum pressure; AREA, support surface of the foot. The percentage of bilateral posterior load is equivalent to the percentage of bilateral anterior load because it is the result of subtracting it from unity.

* Statistically significant at P < .05 (ANOVA test).

Table 3. *Stabilometric data before and after the control manipulation (placebo group)*

	Premanipulation (N = 52)	Postmanipulation (N = 52)	95% confidence interval for the difference	P
LOAD%ANT	32.61 ± 5.658	32.38 ± 6.122	-0.560 to 1.002	.575
LOAD%POS	17.46 ± 6.860	17.64 ± 6.453	-1.012 to 0.640	.663
LOAD%FOOT	50.00 ± 7.108	50.00 ± 6.085	-0.821 to 0.822	1.000
L%ANTBI	65.05 ± 8.736	64.63 ± 9.646	-0.718 to 1.565	.464
L%POSBI	34.94 ± 8.736	35.36 ± 9.646	-1.565 to 0.718	.464
CGF-CGB distance	11.36 ± 2.281	11.42 ± 2.027	-0.339 to 0.223	.685
P _{mean} (kgf/cm ²)	0.67 ± 0.162	0.68 ± 0.165	-0.030 to 0.001	.066
P _{max} (kgf/cm ²)	3.87 ± 1.379	3.90 ± 1.294	-0.172 to 0.114	.688
AREA (cm ²)	135.62 ± 27.079	137.62 ± 27.362	-3.625 to -0.096	.045*

Group values are expressed as mean ± SD. The percentage of bilateral posterior load is equivalent to the percentage of bilateral anterior load because it is the result of subtracting it from unity.

* Statistically significant at P < .05 (ANOVA test).

METHODS

Patients

We performed a simple blind, placebo-controlled, and repeated-measures study in which each patient acted as his or her own control. Fifty-two field hockey players (35 men and 17 women) between 18 and 40 years old (mean = 22.5 years, SD = 3.6 years) were included. Anthropometric variables such as weight (Korona digital scale) and height were collected. The study inclusion criteria required patients to have (a) an ankle sprain of grade II (ie, ligament partially torn, patient reported pain to palpation of the lateral ligament, and swelling on the lateral side of the ankle) as diagnosed by the medical practitioner and (b) manual restriction of the posterior gliding of the talus as assessed by a passive manual test of mobility (Fig 1). Patients were excluded if they had (a) experienced ankle sprain for less than 5 days, (b) grade III ankle sprain (ie, ligament completely torn/functional incapacity), (c) received physiotherapeutic treatment for their ankle sprain, (d) no restriction of the posterior

gliding of the talus as assessed by a passive manual test of mobility, (e) bone fractures, (f) inflammatory diseases (eg, rheumatoid arthritis), or (g) neurologic deficits in the lower limbs.

This study was supervised by the Escuela de Osteopatía de Madrid and approved by its ethical committee. All patients signed the required consent form before the study commenced.

Outcome Measures

A baropodometric study was performed with a Foot Work force platform (Diasu Company, Rome, Italy; capture = 45 × 45-cm real dimension; number of sensors = 4024; frequency = 300 MHz). The measuring system consisted of a force platform placed on the floor. The patients were fitted with a soft cervical collar cuff to avoid cervical oscillations, after which they were instructed to move onto the platform and find a comfortable position with their knees straight. They were not told to place their feet in any special position. A reference point was in front of the patients, depending on their height, and they were asked to maintain

Table 4. Results of the intergroup comparison of the changes found for both groups

	Control	Intervention	95% confidence interval for the difference in mean values	P
Increase in L%POSBI	0.43 ± 5.87	-2.05 ± 5.46	0.939 to 4.04	.016*
Increase in percentage of anterior load	-0.21 ± 4.03	1.02 ± 3.87	-2.325 to -0.164	.04*
Increase in percentage of posterior load	0.21 ± 4.23	-1.03 ± 3.86	0.136 to 2.352	.043*
Increase in percentage of posterior-anterior load	-0.43 ± 5.87	2.06 ± 5.46	-4.040 to -0.938	.016*
Increase in LOAD%FOOT	-0.00 ± 4.22	0.03 ± 4.21	-1.186 to 1.121	.956
Increase in the CGF-CGB distance	0.08 ± 1.34	0.02 ± 1.30	-0.299 to 0.422	.739
Increase in P _{mean}	0.01 ± 0.08	-0.01 ± 0.09	0.012 to 0.034	.181
Increase in P _{max}	0.03 ± 0.73	0.01 ± 0.79	-0.186 to 0.233	.825
Increase in AREA	1.86 ± 9.07	0.83 ± 9.08	-1.452 to 3.511	.414

Group values are expressed as mean ± SD.

* Statistically significant at $P < .05$ (MANOVA test).

their gaze fixed on the reference point and hold their position for 1 minute.

The following data were collected from each patient: percentage of load on the forefoot; percentage of load on the rear foot; percentage of load on the foot; bilateral anterior load; bilateral posterior load; distance from the center of gravity of the foot (CGF) to the center of gravity of the body (CGB); mean pressure; maximum pressure; and support surface of the foot.

Interventions

The patients in the intervention group were subjected to two techniques of manipulative treatment: talocrural joint manipulation (Fig 2) and posterior gliding manipulation over the talus (Fig 3). For the first treatment, the therapist initially applied a high-velocity and low-amplitude caudal thrust directed at the talocrural joint as follows: each patient was placed in the supine position, and the therapist wrapped his or her hands at the level proximal to the leg with the fingers at the level of the neck of the talus and then exerted traction in a caudal direction, increasing the dorsal flexion focused on the talocrural joint (Fig 2). Next, a short-amplitude and high-velocity thrust was exerted, increasing the dorsal flexion.^{40,41}

Second, the patient was placed sitting on a bed with a controlled drop device. The hip of the side to be treated and the knees were in flexion, and the sole of the foot was on a wedge (45° slope), such that the foot was in a resting position. The calcaneus bone was supported on the edge of a drop device, which was primed to drop. The therapist was standing facing the dysfunction in front of the patient. One hand contacted the cubital edge on the neck of the talus, whereas the other hand was placed on top of the first one to reinforce this contact. The forearms pointed in the direction of the foot, with the elbows extended (Fig 3). The posterior gliding manipulative procedure was performed by translation of the body weight of the therapist in the direction of the foot.⁴²

Within the control group, a placebo technique was applied as follows: the physician placed his or her hands

in the same way as that for the talocrural joint manipulation for 1 minute, but no type of caudal traction was carried out.

Statistical Analysis

Data were analyzed with SPSS version 13.0 (SPSS Inc, Chicago, Ill). Mean values and standard deviations were calculated for each variable. A normal distribution of the quantitative data was shown with the Kolmogorov-Smirnov test ($P > .05$). Unilateral analysis of variance was used to assess intragroup differences, whereas multivariate analysis of variance was applied to assess the intergroup comparison on the improvement (pre-post scores) achieved in both interventions. Statistical analysis was conducted at a 95% confidence level. A P value lower than .05 was considered to be statistically significant.

RESULTS

Patients Characteristics

The demographic characteristics of the sample are shown in Table 1. The patients had 1.8 sprains on each foot. In our study, we accepted field hockey players who had had one or more episodes of ankle sprain in one or both ankles. The lowest number of sprains in a single ankle was 1, and the maximum was 9. The minimum number of untreated sprains was 0, and the maximum was 3 for the same patient. A mean of 1.0 ± 1.5 of the sprains received functional treatment with physiotherapeutic interventions. The minimum number of sprains that received treatment was 0, and the maximum was 8 for the same patient. Finally, the mean value of sprained ankles that were immobilized with a rigid splint was 0, and the maximum was 3 for the same patient. The minimum number of ankles immobilized was 0, and the maximum was 3 for the same patient. Therefore, the treatment followed with greatest frequency was of the functional type.

Effects of the Manipulation on Stabilometric Recordings

The results obtained in the intervention group revealed statistically significant differences between the premanipu-

lation as well as postmanipulation values of the percentage of posterior load on the foot ($P = .015$; difference estimated from mean values = 2.13%) and the percentage of bilateral anterior load ($P = .02$; difference estimated from mean values = 2.17%). Other variables (eg, distance from the CGF to the CGB) did not reach statistical significance, probably as a result of greater variability in the data. Neither the pressures nor the support surface revealed significant differences before and after the intervention (Table 2).

On the other hand, the placebo group did not show any change in any of the variables (loads, pressures, and distance from the CGF to the CGB), except in area, which increased significantly, although the confidence interval was broad and such differences could not be confirmed definitively (Table 3).

Multivariate analysis of variance for the intergroup comparison on improvements between groups revealed statistically significant differences in favor of the experimental group for (a) the increase in percentage of posterior load on the manipulated foot, (b) the increase in the percentage of bilateral posterior load, (c) the increase in the percentage of anterior load on the manipulated foot, and (d) the increase in the percentage of bilateral anterior load. The remaining variables, relative to pressure, area, and distance from the CGF, did not show significant differences between groups, although some of them (eg, area) did show important differences in the mean values (Table 4).

DISCUSSION

This study shows preliminary evidence that manipulation of the talocrural joint modified the pattern of behavior of the load support at the level of the foot as compared with placebo manipulation. Talocrural joint manipulation also modified the support surface, although it exerted no relevant effect on the pressure and on the location of the CGF. According to Kibler,⁴³ ankle sprains that are insufficiently rehabilitated have a 77% likelihood of recurrence. Kibler⁴³ also reported that there are some patients with ankle sprains who are treated and evaluated with normal procedures in which the restoration of the function could be considered to be inappropriate and that their symptoms hence continue (pain, restriction of range of motion, and inflammation) during sport practice. Mijares Grau⁴⁴ also stated that a high percentage of chronic instabilities or lasting pain is observed after orthopedic treatment of grade II ankle sprains. From our point of view, it should be possible to modify some of these sequelae with the intervention that we reported on. Changes in pressure lead to a redistribution of weight because foot pressure plays an important role in the variation of amount of body mass supported by each part of the foot. These changes in pressure would be able to alleviate the load suffered by stabilization structures such as ligaments, muscles, and fasciae. Future biomechanical studies are required to evaluate these changes.

Our results support the hypothesis that manipulation of the ankle exerts proprioceptive effects. The mechanical effect is reflected on changes in the percentage of load on the forefoot and rear foot both unilaterally and bilaterally. The existence of load redistribution is accompanied by proprioceptive changes during the standing position because the structures of the ankle adapt their capacity for reaction.

Although no study had evaluated postural equilibrium after talocrural joint manipulation, many authors have assessed the range of movement of the tibia-fibula-talus joint after the same manipulative procedure used in this study. Pellow and Brantingham³⁴ found that caudal manipulation of the talocrural joint improved the range of dorsal flexion of the ankle in patients with ankle sprains of grade I or grade II. In contrast, Fryer et al²⁷ failed to find significant changes in the range of dorsal flexion in asymptomatic patients after the same procedure. It is possible that ankle joint manipulation has different effects for patients with ankle sprains as compared with healthy subjects.

The alignment of the tibia-foot segments, the range of movement of the calcaneus bone, and the position of foot support are usually considered as risk factors in the appearance of ankle sprains.⁴⁵⁻⁴⁷ The variation in load produced after talocrural joint manipulation suggests not only a therapeutic effect able to restore the initial physiologic conditions after a lesion is acquired but also a proprioceptive effect in healthy subjects that points to a therapeutic perspective as long as the factors described appear. Future longitudinal research in different populations should shed further light on these aspects.

CONCLUSIONS

The application of caudal talocrural joint manipulation redistributed foot load in our sample of athletic individuals with grade II ankle sprain. Stabilometric recordings could be used as a suitable method for manual therapy research. Further studies assessing stabilometric and baropodometric changes after peripheral or spinal manipulative procedures are now required.

Practical Applications

- The application of caudal manipulation of the talocrural joint modifies the pattern of behavior of the load support at the level of the foot as compared with placebo manipulation in a sample of athletic individuals with grade II ankle sprain.
- Our results support the hypothesis that manipulation of the ankle exerts proprioceptive effects.
- Stabilometric recordings could be used as a suitable method for manual therapy research.

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